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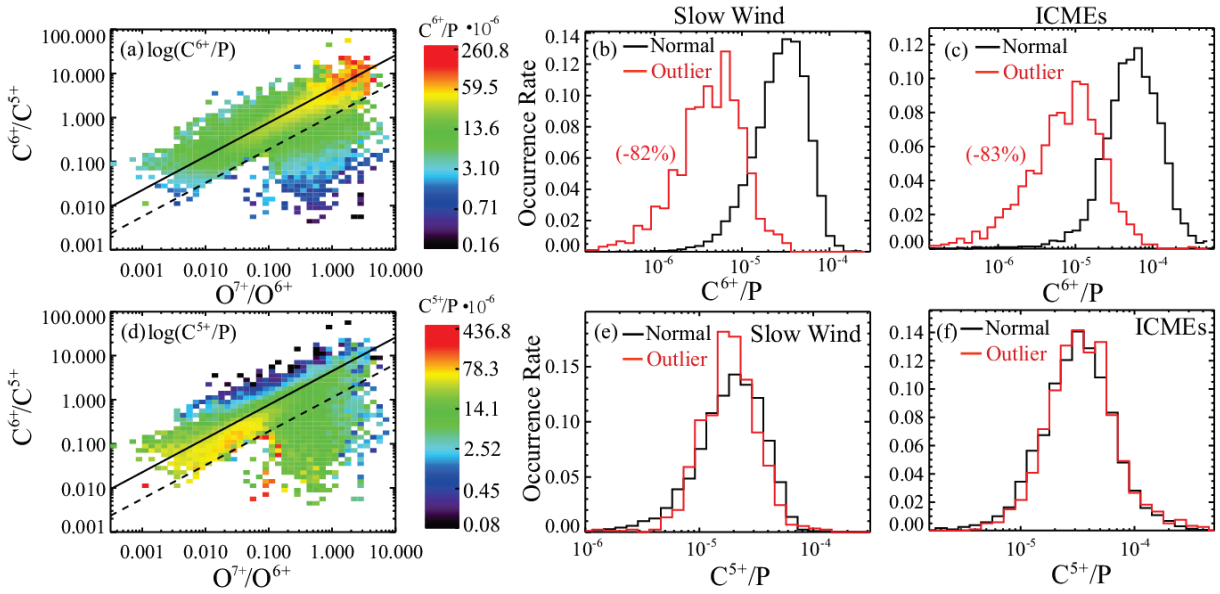
Anomalous Composition in Slow Solar Wind and ICMEs as Observed by ACE/SWICS



Left: Distribution of C^{6+} to proton [C^{6+}/P, (a) and C^{5+}/P (d)] ratio from ACE/SWICS between 1998-2011; solid line is the linear-fitting line of the two ratios in 2007; dashed line is the threshold to identify the Outliers. Middle [right]: comparisons of C^{6+}/P (top row) and C^{5+}/P (bottom row) between Outlier (red) slow wind [ICMEs] and normal (black) slow wind [ICMEs].

The solar wind Oxygen and Carbon charge states (O^{5+} to O^{7+}, and C^{4+} to C^{6+}) freeze-in at very similar heights in the 1.0 – 1.9 solar radii (R_s) range. Since theoretical models predict that the coronal electron temperature monotonically increases with height, we expect that the O^{7+}/O^{6+} and C^{6+}/C^{5+} density ratios are correlated. We monitored these ratios as measured by ACE/SWICS from January 1998 to August 2011 and find that they are correlated everywhere in the solar wind, with the exception of a branch of "Outliers" whose anomalously low C^{6+}/C^{5+} ratios significantly depart from the mainstream distribution (Panel a and d). We use an empirically chosen threshold (dashed lines) to identify these Outlier wind measurements, and find that they are almost evenly split between ICMEs and wind slower than 500 km/s. The population of the Outlier slow wind is about 11% of all of the slow wind, and Outlier ICMEs are about 44% of all ICMEs.

Further analysis reveals that the depletion of the C^{6+}/C^{5+} ratio is due to the large decrease in the abundance of the fully stripped Carbon ion, C^{6+}. In both the slow wind and ICMEs, the Outlier events all show a dramatic depletion of the fully stripped ions (C^{6+}/P, N^{7+}/P, O^{8+}/P, Mg^{12+}/P) compared to the normal counterparts of the winds (Panel a, b and c), while the rest of the wind properties are the same.

One possible scenario responsible for the origin of the Outliers could be that the fully stripped ions are accelerated away from the wind parcels through Coulomb collisions with the energetic proton jets produced by the magnetic reconnection occurring in the solar corona. If confirmed, the Outliers represent a direct signature of the solar wind release through magnetic reconnection. *See Zhao et al. AIP Conference Proceedings, 1720, 020006 (2016) for details.*

This item was contributed by L. Zhao, M. Kocher, E. Landi, S. T. Lepri, T. H. Zurbuchen, L. A. Fisk, and J. A. Gilbert of the University of Michigan. Address questions and comments to lzh@umich.edu. *Please see ACE_News_Archive for earlier ACE News Items.*